SYNOPSIS

Synthesis of Nano-semiconductor and Polymer Based Composite for Optoelectronic Device Applications

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Ms.Mulla Samrin Ayub
Ph.D. student

Under the guidance of
Dr.M. S. Khandekar
Maharashtra Udaygiri Mahavidyalaya Udgir-413517

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1. Introduction

In the field of nano-science and nanotechnology, thin film technology is constantly evolving. Thin films are material layers produced on a substrate. The layers' dimensions range from a few nanometers to a few micrometers. They are constructed on substrates through a controlled condensation of atoms, molecules, and ions. This process is carried out directly through physical processes or indirectly through chemical and electrochemical reactions. Thin films are mostly used in semiconductors, integrated circuits, solar batteries, capacitors, micro electro mechanical systems (MEMS), and protective coatings. Thin films of this type are widely used in optics, sensors, medicinal devices, and other applications. Thin films were first used for decorative purposes in glazes for brickworks and ceramics. Thin films, on the other hand, had a rapid development from the 1980s.

There are numerous approaches for synthesizing thin films; we can try to make thin films using nano-semiconductor and polymer composites to cut costs and obtain new types of performance. Thin films exhibit different optical-mechanical, electrical, and magnetic properties. Because of these characteristics, they are frequently used in a variety of industrial applications. Superconducting technology equipment such as high film magnets, rotating magnetic devices, and power cables, as well as electronic devices, diodes, hard coatings and optical coatings, solar cells, and batteries, are examples of uses.[1] Thin films have recently been employed as sensors for sensing gases, temperature, humidity, pressure, material ions, forces, and chemicals.

By dispersing nano-ZnO in aqueous solutions comprising mixtures of the biodegradable polymers poly (vinyl alcohol) (PVA) and poly (ethylene oxide) (PEO), a variety of poly (vinyl alcohol)/nano-ZnO composites were formed, and composite thin films were created by casting. The addition of nano-ZnO to PVA/PEO mixed solutions dramatically reduced the solutions' resistivity. The thin films' ultraviolet absorbance, thermal behavior, and visco-elastic characteristics were studied as a function of nano-ZnO.[2]

2. Review of literature and development in subject:

It is reported in the literature that the optoelectronic properties of nano-composite materials are investigated, and these properties are found to be applicable in various applications.

B. Ullrich, et al.[3]the optoelectronic properties of thin film CdS formed by ultraviolet and infrared pulsed-laser deposition.

V. Nikam, et al.[4] have performed the synthesis have discussed of various metal oxides nanoparticles.

J. Lee, et al.[5] discussed the properties of nano-ZnO/poly (vinyl alcohol)/poly (ethylene oxide) composite thin films.A series of poly (vinyl alcohol)/nano-ZnO composites were prepared by dispersing nano-ZnO in aqueous solutions containing mixtures of the biodegradable polymers poly (vinyl alcohol) (PVA) and poly (ethylene oxide) (PEO), and composite thin films were prepared by casting.

Rajeev Arora, et al[5] summarized the aspects of TiO_2 and PVA composite materials in polyaniline during the polymerization. Classical composite properties, as thermomechanical, conductive as well as mechanical properties.

Seyedeh Soraya Mousavi et al[6] reported fabrication of a high-speed polymer-based photodiode with the enhanced responsivity. The device produced using a novel kind of the nanocomposite composed of ZnO@GQD core-shell.

Jobin Job Mathen, et al.[7] concluded highly efficient UV-A photo detector was successfully fabricated in the configuration ITO: ZnO/PVA: Al in which ZnO/PVA as active layer by spin coating and thermal evaporation technique. The binary composition exhibited an optimized performance in the UV-A sensor by providing a quick response time of 1.107 s.

Dali Shaoa, et al.[8] reported UV photodetectors were fabricated from PVA-ZnO/MWCNTs/PVA-ZnO composite structures which show enhanced band edge emission and faster transient photo response.

E. J. A. Pope, et al.[9] prepared Transparent silica gel–polymer composites. These materials constitute a new class of *transparent* composites. Properties, such as density, refractive index, modulus of rupture, compressive strength, abrasion rate, and Vickers hardness, have been measured over the compositional range of 100% silica to 100% polymethyl methacrylate (PMMA).

T.Vasuki ,et.al [10] prepared TiO2 thin films prepared and deposited on glass substrate by solgel spin coating method. The characteristics of the investigated thin films are interpreted in terms amorphous-crystalline phase.

3. Objectives of research / Proposed hypothesis:

This work investigates the optoelectronic properties of metal oxide and polymer composite thin films synthesized using spin coating technique on glass substrates. It is possible to develop an optoelectronic device film which is photo responsive by keeping in mind the following objectives.

To achieve this objective this work aims-

a. To synthesize metal oxide (ZnO, TiO_2, SnO_2, etc.) nanoparticles using chemical method
b. To characterize the synthesized nanoaprticles for investigation of its structural, optical and elemental properties using XRD, UV-Vis spectroscopy, photoluminescence, SEM-EDS, etc.
c. To prepare polymer (PVA, PVP, PMMA, etc.) solution and deposition of its thin film on glass substrate using spin coating technique via optimizing its parameters.
d. To synthesize nanoparticles-polymer composite and optimize its composition for getting a smooth and well dispersed thin films.
e. To investigate optoelectronic properties of above composite thin film device, such as; photoconductivity, responsivity, detectivity, sensitivity, gain, response time, etc.
f. To correlate experimental data to obtained results to fabricate a proto type photodetector device.

4. Methodology to be adopted:

Stage 1: Fabrication of Metal Oxide and Polymer based Thin Films:

Synthesis of high-quality metal oxide nanoparticles and its polymer composite thin films on glass substrate using spin coating method.[11] Solutions of nano-composite will be spin-coated onto glass substrate that had thicknesses of 0.2 to 5 μm. [12]

Stage 2: Characterization of Nanoparticles and Composite Thin Films:

The growth mechanism and properties of the films can be well understood by their characterizations using a variety of investigative techniques. Before using the films in applications,

one has to characterize the films to achieve optimum performance of the films prepared. The complete characterization of any material consists of phase analysis, compositional characterization, structural elucidation, micro-structural analysis and surface characterization. The structural, morphological, and optical analysis was carried out by X-ray diffraction, SEM-EDS, optical spectroscopy, etc.[13]–[15]

Stage 3: Development of Optoelectronic Device:

For fabrication of a photodetector device, the film will be deposited on a 5 mm x 10 mm piece of glass substrate and silver electrodes will be made on the film by keeping a electrode gap of 1, 2 and 3 mm. This device will later be used to study its photodetection properties using a dedicated setup.

5. Importance of study /Society application:

The demand for polymer based composites with desirable electrical properties is gradually growing due to the rapid development of the electronic information technology and artificial intelligence industries. Optical: Used to create reflective coatings, anti-reflective coatings, solar cell, monitors, waveguides and optical detector arrays**.** Electrical or electronic: Used to make insulators, conductors, semiconductor devices, integrated circuits and piezoelectric drives In recent years, there has been a rapidly growing interest in conductive polymer composites (CPCs), which combine the electrical conductivity .

***International status*:**

Nowadays, titanium dioxide attracts special attention from researchers working on the creation of new photocatalytic materials. There has been much research into the development, product design, and manufacture of sustainable materials, and polymer materials are among the most promising. Polymer materials and technologies are in high demand across a variety of sectors, including aerospace, defence, mobile technology, medicine, and Internet of Things instruments, but in particular for the electronics industry. The development of polymer devices has been ongoing for many years, for both synthetic and organic polymer materials, and their significance is based on their inherent material properties. These properties enable their use as electrical insulators, adhesives, sealing materials, and surface barriers for commercial electronic kits. The versatility of these polymer materials also helps to lower the cost of manufacturing. New developments in polymer materials have been applied successfully in many disciplines. Descriptive patterns in

printed circuit boards, followed by coating, is a traditional technique used to increase the reliability of electronic kits.

***National status*:**

A number of research outcomes addressing a variety of issues in this field are supported and many are in progress in various national laboratories and universities in India. There has been a rising interest in thermoplastic polymer composites since the past few years, owing to several advantages of these materials, such as high volume processability, recyclability, superior damage tolerance, fracture toughness, and ability to produce complex shapes. These composites can be applied in different modes of transportation, from cars to underground trains. Among thermoplastic composites, long-fiber thermoplastics (LFTs) are being extensively used in the transportation sector. The automotive industry was impacted due to high fuel prices. Furthermore, in the transportation industry, vehicle OEMs and suppliers use thermoplastic composites to reduce vehicle mass.

6. Proposed work plan:

Years	Plan
First Year	Detailed literature survey, selection of system, and setting of the experimental setup.
	Material selection and synthesis of nanoparticles and composite materials. Basic characterization such as XRD, UV-Vis absorption spectroscopy and SEM-EDS.
Second Year	Fabrication of thin films of nano-composite material using spin coating technique and optimization of parameters
	Fabrication of photodetector device and testing it photodetection properties using a dedicated setup.
Third year	Optimizing the thin film parameters (thickness, concentration of nanoparticles in polymer, viscosity of polymer, etc.) to get best photodetection properties of the device.
	Analysis of the obtained research data and publication of research paper**.** Submission of final synopsis and writing of thesis

7. References:

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Signature
Research Scholar

Signature
Research Supervisor
(Guide)